Search for Dirac magnetic monopole in high energy nucleus-nucleus collisions*

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This paper reports on the first search for the magnetic monopole production in high energy nucleus-nucleus collisions from three sets of experiments conducted at BNL AGS and CERN SPS over the past several years. Using BP-1 barium phosphate glass detector arrays [1], these experiments were designed to detect classic Dirac structureless monopoles with $n \geq 2$ in ultrarelativistic heavy ion collisions. Table 1 summarizes the beam, target, and detector information, together with obtained upper limits on the production cross section at 90% confidence level.

Experiment	E882-I	E882-II	P288
Accelerator	AGS, BNL	AGS, BNL	SPS,CERN
Beam Ion	^{197}Au	^{197}Au	^{208}Pb
Energy (A GeV)	$\simeq 11$	$\simeq 11$	$\simeq 160$
Target (g cm^{-2})	14.4	7.21	7.21
Detector (cm^3)	5×5×0.07	10×10×0.1	10×10×0.1
# of Plates	$2+15$	$2+10$	$2+18$
Beam Fluence	3.50×10^9	1.92×10^{11}	6.60×10^{10}
# of Interactions	1.05×10^9	3.08×10^{10}	1.46×10^{10}
Upper Limit (nb)	20	0.65	1.90

Table 1: Summary of three experimental searches. Upper limits on Dirac monopole production cross section are given at 90% confidence level. The number of interactions was estimated based on total interaction cross sections measured at AGS [2] and SPS [3].

I used an automated measurement system [4] to scan glass plates and measure the geometry of each identified track. The on-line image analysis algorithm identified tracks and extracted parameters of an elliptical fit to track mouths. These measurements allowed one to determine the instantaneous value of ionization rate, in particular, Z/β, at various depths as a highly ionizing particle of charge Z and velocity βc passes through the detector array.

Three classes of events could register in the detector arrays: (1) a Dirac magnetic monopole, signaled uniquely by a decrease of ionization rate with penetrating depth; (2) candidates for an ultradense nuclear object, recognizable by $Z \geq 85$ and $\beta \geq \beta_{\rm cm}$ (= 0.915 at AGS and = 0.994 at SPS); and (3) background fragments with $Z/\beta \geq 85$ and $Z \leq Z_{\rm beam}$ that slowed through a large thickness of beam pipe or in interactions leading to fragments with intermediate rapidity emitted in nearly the forward direction.

No candidates were found in 1.05×10^9 and 3.08×10^{10} interactions of 11 A GeV Au nuclei and 1.46×10^{10} interactions of 160 A GeV Pb nuclei with Pb targets. The upper limits, on order of nb, on the production cross sections for Dirac magnetic monopoles and other hypothetical highly-ionizing objects are well below those predicted via the Drell-Yan mechanism [5].

Following the publication of my results in the October 27th issue of *Physical Review Letters*, the work was commented on in a report entitled "Magnetic Monopoles: Absence of Evidence" in Science and Technology of *The Economist* (London) in its November 1st issue (1997).

References

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